

**PATENT APPLICATION**

**MODEL ROAD RACE GAME WITH SENSOR MATS**

Inventor(s): **Louis G. Kovach, II**, a citizen of the United States, residing at  
43774 Bemis Road  
Belleville, Michigan 48111

**Neil Young**, a citizen of Canada, residing at  
3240 Bear Gulch Road  
Redwood City, California 94062

Assignee:

Entity: Independent Inventor

## **MODEL ROAD RACE GAME WITH SENSOR MATS**

### **CROSS-REFERENCE TO RELATED APPLICATIONS**

[0001] This application is related to copending Application No. 10/346,558, filed January  
5 16, 2003, entitled "Dynamic Self-Teaching Train Track Layout Learning and Control  
System", which disclosure is incorporated herein by reference.

### **STATEMENT AS TO RIGHTS TO INVENTIONS MADE UNDER FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT**

10 [0002] NOT APPLICABLE

### **REFERENCE TO A "SEQUENCE LISTING," A TABLE, OR A COMPUTER PROGRAM LISTING APPENDIX SUBMITTED ON A COMPACT DISK.**

[0003] NOT APPLICABLE

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### **BACKGROUND OF THE INVENTION**

[0004] The present invention relates to model vehicles, in particular to systems for locating  
vehicles.

[0005] US Pat. No. 6,480,766 contains a discussion of different systems, including satellite  
20 Global Positioning Systems (GPS) for determining the location of a particular full sized (not  
model) train. US Pat. No. 5,803,411 shows a train which detects position indicators along the  
side of a track, and provides these to an onboard computer for determining the position,  
speed, etc. of the train.

[0006] The arrival of a train on a section of track can be detected in some systems, such as  
25 by detecting the load on the current applied to the track, and can be used to activate certain  
elements connected to the track, such as a switch or a stoplight (see, e.g., US Pat. No.  
5,492,290).

[0007] US Pat. No. 4,349,196 shows a system with a unique bar code on the bottom of each  
train car, with detectors mounted in the track below. This allows a determination of which  
30 car is over the sensor, and which cars have been assembled in a train. US Pat. No. 5,678,789

shows a system with sensors in the track for detecting the position and velocity of a passing train.

[0008] It would be desirable to locate model vehicles, such as model cars, which aren't restricted to a fixed track.

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## BRIEF SUMMARY OF THE INVENTION

[0009] The present invention provides a method and apparatus for determining the location of a particular model vehicle. Position detector elements are placed around a game area where the vehicles will travel. Transmissions between the vehicle and a position detector element it passes allow the ID of one to be sent to the other. Then either the position detector  
10 element or the vehicle transmits a message to a controller with both the ID of the vehicle, and the ID of the position detector element, allowing the determination of which vehicle is where.

[0010] In one embodiment, the position detection elements are sensors which detect an emitted ID from the vehicle, and also detect the speed and direction of the vehicle. This information is then relayed to a control system. In another embodiment, the vehicle detects  
15 the position detection element, and relays this information, along with the train ID, speed and direction, to the control system. This second embodiment uses wireless transmissions. The first embodiment could use either wired or wireless connections to the position detector elements.

[0011] In one embodiment, the position detector consists of multiple sensors placed in a  
20 mat, and connected to a transmitter in the mat. The mats can be placed around the race area, with race cars either passing over them, passing on a roadway over them, or simply going around them.

[0012] Other applications of the present invention will become apparent to those skilled in the art when following the description of the best mode contemplated for practicing the  
25 invention this read in conjunction with the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The description herein makes reference to the accompanying drawings wherein like reference numerals refer to like parts throughout the several views, and wherein:

[0014] Figure 1 is a model vehicle and sensor mat according to an embodiment of the  
30 present invention;

[0015] Figure 2 is a schematic representation of a transmitter according to an embodiment of the present invention;

[0016] Figure 3 is a schematic representation of a receiver according to an embodiment of the present invention;

[0017] Figure 4 is a diagram of a race area showing the placement of sensor mats.

[0018] Figure 5 is a flow chart detailing the steps for transmitting a message by a

5 transmitter according to an embodiment of the invention;

[0019] Figure 6 is a schematic representation of a message exchanged between a transmitter to a receiver according to an embodiment of the present invention;

[0020] Figure 7 is a schematic representation of a burst communicated as part of a message according to an embodiment of the present invention;

## 10 DETAILED DESCRIPTION OF THE INVENTION

### Active Sensor Embodiment

[0021] The present invention provides a method and apparatus for controlling one or more model vehicles (although a car is referred to herein, other vehicles could be used, such as a boat, truck, etc.). The embodiment of Fig. 1 shows a model vehicle 16 with a transmitter 10  
15 connected its underside. When vehicle 16 passes over or near a sensor mat 12, transmitter 10 can transmit information associated with the car 16, such as car type and car number, to detectors 25 and 26 in receiver mat 12. Receiver 12 can receive the information from the transmitter 10 and communicate the information by wire or wirelessly to a vehicle controller. The vehicle controller can receive information from receiver 12 and emit commands to the  
20 car 16 in accordance with a control program stored in memory. The transmitter 10 can be powered by the same power source that powers the car 16.

[0022] Referring now to Fig. 2, transmitter 10 can include a controller 44 and a light emitting diode 46. The controller 44 can control the light emitting diode 46 to emit infrared radiation pulses in a predetermined pattern. The predetermined pattern corresponds to  
25 information associated with the car. The predetermined pattern can be defined by the duration of individual infrared radiation pulses and the time period between pulses. Transmitter 10 can continuously repeat the predetermined pattern to enhance the likelihood that the information will be accurately received by the receiver 12.

[0023] In a preferred embodiment of the present invention, the transmitter 10 is a  
30 modulated infrared emitter, operable to emit infrared radiation having a wavelength in the range of 800 nanometers to 1000 nanometers. In a more preferred embodiment, the light emitting diode 46 emits infrared radiation in the range of 870 nanometers to 940 nanometers. Emitting infrared radiation within the range of 800 nanometers to 1000 nanometers enhances

the rejection of visible light by the receiver 12. Visible light detracts from the quality of the information exchanged between the transmitter 10 and the receiver 12. A light emitting diode 46 is available for purchase from many manufacturers, including Lite On®, part number LTE-4206, and Toshiba®, part number TLN110. Preferably, the emission angle of the light emitting diode 46 is from 15° to 25° and the energy level is approximately 0.7 mW/cm<sup>2</sup>.

[0024] The controller 44 can be coupled to the engine 43 of a model car to determine the speed of the engine 43 as well as the hours of operation of the engine 43. The controller 44 can communicate this information to the receiver 12 by controlling the light emitting diode to emit a predetermined pattern of infrared radiation pulses. Also, the controller 44 can receive electromagnetic wave signals from the controller 14 or from another source and stop the engine 43 or reduce the speed of the engine 43 in response to the wave signals. With respect to other sources of wave signals, a human operator, for example, can cause wave signals to be directed to the controller 44 to slow or stop the engine 43.

[0025] The transmitter 10 can emit a plurality of different predetermined patterns of infrared radiation pulses corresponding to different information or can emit a single predetermined pattern. For example, a first predetermined pattern can correspond to a car number of the car. A second predetermined pattern can correspond to a car type. Furthermore, various categories of cars can be further defined to enhance the specificity of the information transmitted by the transmitter. For example, the transmitter can transmit a message to the receiver that indicates that the car 16 is a cargo car carrying the particular type of cargo. In an embodiment of the invention in which the controller 44 communicates with the engine 43, the information communicated can include the hours of operation of the engine 43 and/or the motor speed of the engine 43. In a preferred embodiment of the invention, the transmitter 10 can at least emit a first predetermined pattern of infrared radiation pulses corresponding to a car number of the car

[0026] Referring now to Fig. 3, detectors 25 and 26 can receive information from the transmitter when the transmitter is in predetermined proximity with the receiver 12. The receiver 12 can include only one detector 25, or two detectors 25 and 26, or alternately 3 or more detectors. The detectors detect the predetermined pattern of infrared radiation pulses from the light emitting diode 46 of the transmitter 10 and communicate the predetermined pattern to a processor 28 of the receiver 12. An obstructing member can be positioned between the detectors 25 and 26 to limit a range of reception of the detectors 25 and 26 with

respect to each other. Also, the distance between the detectors 25 and 26 can be varied to control the range of reception of each detector 25 or 26 with respect to each other.

[0027] The detectors 25 and 26 are mountable on an upwardly facing surface 27 to receive the information from the transmitter 10. However, the detectors 25 and 26 can be positioned adjacent an anticipated path of the car if the transmitter does not transmit information downward.

[0028] Receiver 12 can also include an amplifier 90 and a filter 92. The amplifier 90 can reduce errors caused by the reception of multiple signals at a single receiver 12. In particular, the gain of the amplifier 90 can be selected to control the range of reception. The amplifier 90 permits a predetermined range of reception for signal information recovery, but limits the predetermined range to exclude adjacent sensors. The filter 92 can reject ambient light pulses of the same wave length as the signal emitted by the transmitter 10. The receiver 12 can be tuned to the same wavelength as the transmitter to provide band pass filtering.

[0029] Processor 28 can receive signals from detectors 25 and 26 corresponding to the predetermined pattern of infrared radiation pulses transmitted by the transmitter 10. Processor 28 converts the signals received from the detectors 25 and 26 into a form of information usable by the controller 14 and communicates the information to the controller 14. In addition, the processor 28 can uniquely identify the receiver 12 to the controller 14 with respect to every other receiver or any other device communicating with the controller 14 positioned along the path. The processor 28 will identify the receiver 12 to the controller 14 each time information is communicated to the controller 14.

[0030] Information corresponding to the model car moving along the path is transmitted from the model car by the transmitter and is received by the receiver. The information corresponding to a model car that can be transmitted includes car number, car type, engine speed of model car engine and operating hours of a model car engine.

[0031] Fig. 4 illustrates four receivers 12a, 12b, 12c, and 12d positioned around a race area. Each includes multiple detectors, and in this embodiment, each includes a transmitter 29 for wirelessly transmitting information to controller 14. As a vehicle 16 passes over or in close proximity to receiver 12a, its position, speed, and direction are transmitted to controller 14.

In one embodiment, receiver 14 is a very thin mat into which the detectors and transmitter are embedded. The mat can be sufficiently thin so as to allow the vehicle to easily pass over it. Alternately, a roadway can be used, with the mat/receiver 12 being placed under the roadway.

[0032] Referring to Fig. 5, a simplified flow diagram illustrating the steps for transmitting information by the transmitter is provided. The process starts at step 48. At step 50, the

information to be transmitted is retrieved from memory. The information includes at least two components: index data and parameter data. Index data corresponds to a genus of information and parameter data corresponds to a species of information within the genus. For example, the index data can correspond to the genus model train engines and the parameter data can correspond to a particular model train engine. In a preferred embodiment of the present invention, index values are assigned according to the table provided immediately below:

<u>Index Value</u>	<u>Parameter Data</u>
0	Car Number
1	Car Type
2	Engine Speed MSB
3	Engine Speed LSB
4	Operating Hours MSB
5	Operating Hours LSB

At step 52, the index data and parameter data are used to calculate an integrity byte. The integrity byte will be transmitted by the transmitter with the index data and parameter data. After receiving the information from the transmitter, the receiver can compare the integrity byte to the index data and the parameter data to verify the accuracy the index data and the parameter data. If the integrity byte is not consistent with respect to the index data and the parameter data, the receiver can reject the information received from the transmitter as erroneous. The method for calculating the integrity byte will be described in greater detail below.

**[0033]** At step 54, the index data, parameter data and the integrity byte are converted into nibbles. As used herein, a nibble is a quantity of data having four bits.

**[0034]** At step 56, each nibble is converted from a four bit format to a five bit format. The nibbles are encoded from four bit to five bit data by the transmitter and decoded from five bit data to four bit data by the receiver. Encoding the information enhances the accuracy of information transmitted by the transmitter and received by the receiver. In particular, four to five bit encoding doubles the number of bit combinations and enhances the detection of invalid transmissions by the receiver because half of the total number of combinations is

known to be invalid. The present invention can be practiced with encryption that encodes the four bit data into any number of bits greater than five, such as “four to six” bit encoding.

[0035] After the completion of steps 50 through 56, the transmitter can begin to transmit information to be received by the receiver. The information will be transmitted as a message including the index data, parameter data and the integrity byte. The transmitter can be operable to transmit more than one message. Each message will be transmitted as a predetermined pattern of infrared radiation pulses. Acceptance of the message by the receiver for communication to the controller is determined by comparing the pattern of pulses to a communication protocol. The communication protocol defines a plurality of successive time periods during which infrared radiation pulses must be received by the receiver. If the pulses are not received by the receiver according to the time periods defined by the communication protocol, the information is rejected by the receiver and not communicated to the controller. The communication protocol will be discussed in greater detail below.

[0036] The steps for transmitting information by the transmitter continues at step 58 and the light emitting diode generates infrared radiation pulses corresponding to the information to be transmitted. Step 62 monitors whether the entire message has been sent. If not, the process returns to step 58 and the additional information is transmitted. If the information has been fully transmitted, the process continues to step 64 and is delayed according to the communication protocol. The delay lasts more than 150 microseconds. After the delay, the process returns to step 50.

[0037] Referring now to Fig. 6, a sample message 32 conforming to the communication protocol of a preferred embodiment of the invention is illustrated. Horizontal line 34 is a schematic representation of time. The predetermined pattern of message 32 is defined by bits 38, representing an operational state of the light emitting diode of the transmitter, and can be divided into eight distinct bursts 36a-36h of data. Each burst of data can be divided into six bits 38 of data.

[0038] Referring now to Fig. 7, each bit 38a-38h represents an operational state of the light emitting diode during a particular time period. The light emitting diode can be on or off and the receiver can assign a value to each bit 38a-38h based on the operational state. For example, if the light-emitting diode is emitting infrared radiation during the period of the second bit 38b, bit 38b can be assigned a value of 0 by the receiver. Conversely, if the light-emitting diode is not emitting infrared radiation during the period of the second bit 38b, bit 38b can be assigned a value of 1 by the receiver. Bits 38a - 38f are schematic



representations and can have a value of 1 or 0. Each bit 38 preferably lasts 4 microseconds, +/- 20%.

[0039] The first bit 38a, or start bit, of the first burst 36a initiates the exchange information between the transmitter and the receiver. Preferably, the start bit 38a will always be 0, representing that the light-emitting diode is on. The start bit can be assigned a value of 0 to synchronize the timing sequence of data transmission. If the start bit 38a were not assigned a value of 0, the receiver could not verify when a second burst begins after a first burst has ended.

[0040] The five bits 38b-38f of burst 36a correspond to the nibble of the data. The five data bits 38b-38f can correspond to index data, or parameter data, or the integrity byte.

[0041] The time period lasting from the beginning of a first bit 38a to the beginning of a second bit 38b is preferably 10 microseconds, +/- 5%. The time period lasting from the beginning of the last bit 38f of a first burst 36i to the beginning of a first bit 38g of a second burst is between 104 microseconds to 150 microseconds. The time period lasting between the beginning of the last bit of the last burst of a first message to the first bit of the first burst of a second message is greater than 150 microseconds. In a preferred embodiment of the present invention, the receiver recognizes the beginning of a new message if the period of time between the start of the bit 38a to the start of the bit 38g is greater than 150 microseconds.

[0042] Each burst must contain at least two bits assigned a value of 0, in addition to the start bit. A burst received by a receiver that does not include two or three bits having an assigned value of 0 will be considered invalid by the receiver and will not be communicated to the controller. Furthermore, if one burst of a particular message is rejected, the entire message is rejected. It has been recognized that by requiring each burst to include at least two bits having an assigned a value of 0 increases the likelihood that the information to be transmitted will be accurately transmitted to the receiver. It is assumed that by requiring at least two bits assigned a value of 0 tends to enhance the rejection of bursts corrupted by natural light, electrical noise or other infrared sources.

[0043] In a preferred embodiment of the invention, data is communicated according to the burst pattern provided immediately below:

<u>Burst Value</u>	<u>Hex Data Value</u>
001011	0
010011	1
010100	2
001001	3
010110	4
000101	5
001110	6
010010	7
001010	8
000110	9
011010	A
001100	B
001101	C
010101	D
011001	E
010001	F

Each burst can be asynchronous with respect to the preceding burst. The time periods between successive bursts are selected to enhance the likelihood of successful data transmission. Specifically, the time periods associated with each component of a message 32 are minimized to enhance the likelihood that a message 32 can be transmitted several times while the transmitter is in predetermined proximity with respect to the receiver even if the car 16 is traveling at its most extreme velocity.

[0044] Referring now to Fig. 7, the first two bursts, 36a and 36b, of the message 32 correspond to index data. The third through six bursts, 36c through 36f, correspond to parameter data. The seventh and eighth bursts, 36g and 36h, correspond to the correction byte. After burst 36h is an inter-message gap to separate the messages.

[0045] The index data included as the first two bursts 36a and 36b of the message 32 identifies the category of parameter data to be transmitted in the succeeding bursts 36c through 36f. The index is made up of one byte of data and can contain up to 256 locations. Preferably, a value of 0 is assigned to the index representing the highest priority data being transmitted by the transmitter 10.

[0046] The parameter data is data particular to the corresponding car 16 and corresponds to the index data. For example, the index data of a particular message can be 0, corresponding to a car number, and the associated parameter data can be, by way of example and not

limitation, 25. The message communicated to the controller by the receiver would advise the controller that train car number 25 is in predetermined proximity to the receiver. Parameter data and index data can be preprogrammed with respect to the transmitter. The parameter data for a particular message is made up of two bytes of information. Preferably, the parameter data communicated by the transmitter to the receiver will at least include the number of the car.

[0047] Bursts 36g and 36h correspond to the integrity byte (the correction or check byte). The integrity byte enhances the likelihood of successful transmission of the message between the transmitter and the receiver. In particular, the integrity byte corresponds to the parameter data (rotated and exclusive-ORed) and is compared to the parameter data by the receiver (after reversing the exclusive-OR and shifting). If the integrity byte and the parameter data do not correspond, the message 32 is rejected as erroneous.

#### Passive Sensor Embodiment

[0048] In another embodiment of the invention, the car detects the sensors along its path, rather than the other way around. The sensors can in fact be passive, such as a bar code or other marker that can be read. In one embodiment, the sensors constantly transmit a digital pattern corresponding to their ID, similar to the infrared transmission discussed above. A receiver on the car detects this, and then forwards it, along with the car ID, the car velocity and car direction, to the master controller.

[0049] The car can determine its own velocity from the rotation of its wheels and can determine its own direction from whether positive or negative voltage is applied to its motor, for example.

[0050] This embodiment eliminates the need for multiple sensors to be connected to the controller, either by wires or wirelessly, to provide the desired position information. Instead, the car can itself transmit the information wirelessly. Each sensor, or position indicator, can be then assigned a number as the car detects them, with the controller determining which ones are next to each other as the car passes them. In one embodiment, each sensor transmits a unique ID.

#### Determination of Speed and Direction

[0051] By using two sensors on each mat, the speed and direction of a car can be determined based on which sensor detects the car first, and how long it takes the second sensor to pick up the car. This is described in more detail in the copending application

referenced above. Using three sensors allows detection of direction and speed even if the car passed perpendicular to the first two sensors, thwarting their ability to determine speed and direction from two sensors alone.

**[0052]** While the invention has been described in connection with a particular embodiment,

5 it is to be understood that the invention is not to be limited to the disclosed embodiments.

For example, the transmission to the controller could be from the vehicle or a sensor.

Accordingly, the invention is intended to cover various modifications and equivalent

arrangements included within the scope of the appended claims, which scope is to be

accorded the broadest interpretation so as to encompass all such modifications and equivalent

10 structures as is permitted under the law.